Curriculum Vitae for
Dr. Bradley Jefferson Clement

November, 2007

http://ai.jpl.nasa.gov/public/home/bclement

Work Address
Jet Propulsion Laboratory
M/S 126-347
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6025 Prairie Falcon Drive
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Research Objective and Interests

Create new artificial intelligence techniques and systems that contribute to research and have an immediate and future positive impact in application. Interests: integrated artificial intelligence, multiagent coordination, robotics, abstraction, planning, scheduling, distributed systems, real-time systems, control architectures, AI in games.

Education

University of Michigan, Ann Arbor, MI 8/96-12/01
Ph.D. Computer Science and Engineering 4/02
Dissertation: *Abstract Reasoning for Multiagent Coordination and Planning*
Advisor: Edmund Durfee
M.S. Computer Science and Engineering 4/98
Georgia Institute of Technology, Atlanta, GA 9/88-6/94
B. Computer Engineering, Coop Program, Highest Honor 6/94

Work History

Jet Propulsion Laboratory, Pasadena, CA
Senior Technical Staff, Artificial Intelligence Group 2/02-present
Technical Staff, Artificial Intelligence Group 8/00-2/02
University of Michigan, Ann Arbor, MI
Electrical Engineering and Computer Science Department
Graduate Student Research Assistant 8/96-12/01
Graduate Student Instructor, Discrete Mathematics 1/98-4/98
Matsushita Electric Works, Ltd., Osaka, Japan 9/94-7/96
Software Research Engineer, Intelligent Building Systems R&D Lab
International Business Machines, Corp., Atlanta, GA 4/90-6/94
Cooperative Education Computer Engineering student (9 quarters)
Photocircuits Atlanta, Peachtree City, GA 4/89-3/90
Cooperative Education Mechanical Engineering student (2 quarters)

Honors and Awards

NASA Space Act Award, Abstract Reasoning for Multiple Rover Coordination, 2003
(http://icb.nasa.gov, Space Act Award recognizes outstanding scientific or technical contributions sponsored, adopted, supported, or used by NASA which are significant to aeronautics and space activities.)

JPL Level C Awards
(accomplishment impacts the efficiency and success of directorate or division.)

- DARPA Coordinators MDP planner, 2006
- Service Scheduling Subsystem Request for Proposals, 2006
- Distributed Coordination, 2001

JPL Certificates of Recognition

(for the creative development of a technical innovation which has been proposed for publication as a NASA Tech Brief)

- B. Clement, S. Schaffer, G. Rabideau. "CTAEMS MDP Optimal Planner," 2006.
- B. Clement, M. Johnston, A. Wax, C. Chouinard. "Deep Space Network Scheduling Engine," 2006
- S. Schaffer, B. Clement, S. Chien. "Probabilistic Reasoning for Plan Robustness," 2005
- S. Chien, G. Rabideau, D. Tran, R. Knight, C. Chouinard, T. Estlin, D. Gaines, B. Clement, A. Barrett. "CASPER 2.0" (Continuous Activity Scheduling Planning Execution and Replanning), 2005
- B. Clement, S. Schaffer. "Deep Space Network Requirement Scheduler," 2004
- B. Clement. "Distributed Network Scheduler," 2003
- B. Clement, A. Barrett. "Distributed Planning Control," 2003
- B. Clement, "Shared Activity Coordination (SHAC)," 2002
- B. Clement, A. Barrett, G. Rabideau, R. Knight. Abstract Reasoning for Multiple Rover Coordination, 2001.

Student Honors and Awards

- National Merit Scholar
- Georgia Tech Merit Award
- Samuel P. Bratton Scholarship (based on financial need, scholastic achievement, and activities)
- Louise M. Fitten Scholarship (based on scholastic achievement)
- Phi Kappa Phi Honor Society
- Gamma Beta Phi Honor Society
- Golden Key National Honor Society
- Tau Beta Pi Honor Society
- Eta Kappa Nu Honor Society

Publications and Presentations

Journal Article

- Bradley J. Clement, Edmund H. Durfee, Anthony C. Barrett. "Abstract Reasoning for Planning and Coordination." *Journal of Artificial Intelligence Research* (JAIR), Volume 28, 453—515, 2007.

Highly refereed conferences

- Mark D. Johnston, Bradley J. Clement. "Automating Deep Space Network Scheduling and Conflict Resolution." *Proceedings of the Fifth International Joint Conference on Autonomous Agents and Multiagent Systems* (AAMAS-06), 2006.
- Bradley J. Clement, Mark D. Johnston. "The Deep Space Network Scheduling Problem." *Proceedings of the Seventeenth Innovative Applications of Artificial Intelligence Conference on Artificial Intelligence* (IAAI-05), 1514-1520, 2005.
- Steven R. Schaffer, Bradley J. Clement, Steve A. Chien. "Probabilistic Reasoning for Plan Robustness." *Proceedings of the Nineteenth International Joint Conference on Artificial Intelligence* (IJCAI-05), pp. 1260-1265, 2005.
- Bradley J. Clement, Anthony C. Barrett. "Continual Coordination through Shared Activities." *Proceedings of the Second International Joint Conference on Autonomous Agents and Multiagent Systems* (AAMAS-03), pp. 57-64 2003.
- Bradley J. Clement, Anthony C. Barrett, Gregg R. Rabideau, Edmund H. Durfee. "Using Abstraction to Coordinate Multiple Robotic Spacecraft." *IEEE/RSJ International Conference on Intelligent Robots and Systems* (IROS-01), pp. 2140-2147, 2001.

- Bradley J. Clement, Anthony C. Barrett, Gregg R. Rabideau, Edmund H. Durfee. "Using Abstraction in Planning and Scheduling." *Proceedings of the Sixth European Conference on Planning* (ECP-01), 2001.
- Bradley J. Clement, Edmund H. Durfee. "Theory for Coordinating Concurrent Hierarchical Planning Agents Using Summary Information." *Proceedings of the Sixteenth National Conference on Artificial Intelligence* (AAAI-99), pp. 495-502, 1999.
- Bradley J. Clement, Edmund H. Durfee. "Top-Down Search for Coordinating the Hierarchical Plans of Multiple Agents." *Proceedings of the Third International Conference on Autonomous Agents* (AA-99), pp. 252-259, 1999.
- Bradley J. Clement, Edmund H. Durfee. "Scheduling High-Level Tasks among Cooperative Agents." *Proceedings of the Third International Conference on Multi-Agent Systems* (ICMAS-98), pp. 96-103, 1998.

Refereed publications

- Bradley J. Clement, Mark D. Johnston, Daniel Q. Tran, "Experience with a Constraint and Preference Language for DSN Communications Scheduling." To appear in *Proceedings of the International Symposium on Artificial Intelligence, Robotics, and Automation in Space* (iSAIRAS-08), 2008.
- Bradley J. Clement and Mark D. Johnston, "Design of a Deep Space Network Scheduling Application", *Proceedings of the 5th International NASA Workshop on Planning and Scheduling for Space* (IWPSS-06), 2006.
- Loren Clare, Bradley Clement, Jay Gao, Joseph Hutcherson, and Esther Jennings. "Space-Based Networking Technology Developments in the Interplanetary Network Directorate Information Technology Program." *Proceedings of the 2nd International Conference on Space Mission Challenges for Information Technology* (SMC-IT-06), 2006.
- Doran Chakraborty, Sabyasachi Saha, Sandip Sen, and Bradley Clement, "Negotiating assignment of disaster monitoring tasks." Proceedings of the *Workshop on Agent Technology for Disaster Management, International Joint Conference on Autonomous Agents and Multiagent Systems*, 2006.
- Mark D. Johnston, Bradley J. Clement. "Automating Deep Space Network Scheduling and Conflict Resolution." *Proceedings of the 8th International Symposium on Artificial Intelligence, Robotics and Automation in Space* (iSAIRAS-05), 2005.
- Bradley J. Clement, Steven R. Schaffer. "Distributed Scheduling for a Space Network." Poster Session, *Proceedings of the 4th International Joint Conference on Autonomous Agents and Multiagent Systems* (AAMAS-05), pp. 1283-1284, 2005.
- Bradley J. Clement, Anthony C. Barrett, Steven R. Schaffer. "Argumentation for Coordinating Shared Activities." *Proceedings of the 4th International NASA Workshop on Planning and Scheduling for Space* (IWPSS-04), pp. 44-51, 2004.
- Bradley J. Clement, Steven R. Schaffer. "Distributed Network Scheduling." *Proceedings of the 4th International NASA Workshop on Planning and Scheduling for Space* (IWPSS-04), pp. 266-273, 2004.
- Steven R. Schaffer, Steve A. Chien, Bradley J. Clement. "Probabilistic Reasoning for Robust Plan Execution." *Proceedings of the 4th International NASA Workshop on Planning and Scheduling for Space* (IWPSS-04), pp. 172-178, 2004.
- Bradley J. Clement, Steven R. Schaffer. "Distributed Network Scheduling." *JPL IPN Progress Report*, Mar. 2004.

- Bradley J. Clement, Anthony C. Barrett. “Continual Coordination of Spacecraft through Shared Activities.” *Proceedings of the 3rd International NASA Workshop on Planning and Scheduling for Space* (IWPSS-02), 2002.
- Hyuckchul Jung, Milind Tambe, Anthony Barrett, Bradley Clement. “Enabling Efficient Conflict Resolution in Multiple Spacecraft Missions via DCSP.” *Proceedings of the 3rd International NASA Workshop on Planning and Scheduling for Space* (IWPSS-02), 2002.
- Bradley J. Clement, Anthony C. Barrett. “Coordination Challenges for Autonomous Spacecraft.” *Workshop Notes on Multiagent System Problem Spaces*, AAMAS, 2002.
- Bradley J. Clement, Anthony C. Barrett. “Continual Coordination of Shared Activities.” *Workshop Notes on Planning with and for Multiagent Systems*, AAAI, pp. 7-14, 2002.
- Bradley J. Clement, Anthony C. Barrett, Gregg R. Rabideau. “Using Abstraction in Multi-Rover Scheduling.” *Proceedings of the 6th International Symposium on Artificial Intelligence, Robotics and Automation in Space* (iSAIRAS-01), 2001.
- Bradley J. Clement, Edmund H. Durfee. *Exploiting Domain Knowledge with a Concurrent Hierarchical Planner*. AIPS Workshop on Analysing and Exploiting Domain Knowledge for Efficient Planning, Working Notes, pp. 57-62, 2000.
- Bradley J. Clement, Edmund H. Durfee. *Identifying and Resolving Conflicts among Agents with Hierarchical Plans*. AAAI Workshop on Negotiation: Settling Conflicts and Identifying Opportunities, Technical Report, pp.6-11, 1999.

Publications in Books

- Bradley J. Clement, Anthony C. Barrett. “Coordination Challenges for Autonomous Spacecraft.” Wagner, T. (editor), *An Application Science for Multi-Agent Systems*, Series: Multiagent Systems, Artificial Societies, and Simulated Organizations, Vol. 10, 1-Springer, pp. 1-9, 2004.
- Bradley J. Clement, Edmund H. Durfee. “Performance of Coordinating Concurrent Hierarchical Planning Agents Using Summary Information.” *Intelligent Agents VII: Agent Theories, Architectures, and Languages*, Springer, pp. 213-227, 2001.

Invited Talks and Panels

- John Strassner, Jonathan Dale, H. Van Dyke Parunak, Bradley J. Clement, Simon Thompson, AAMAS 2007 Industry Track Panel.
- Bradley J. Clement, Invited Panel “Visionary Statements,” AAAI 2006 Workshop on Auction Mechanisms for Robot Coordination, 2006.
- Bradley J. Clement, “Distributed Constraint Reasoning for Space Applications,” IJCAI 2005 Workshop on Distributed Constraint Reasoning (DCR-05), 2005.
- Bradley J. Clement, Steve A. Chien, Daniel Q. Tran, “Making Agents Safe for Space,” AAMAS 2005 2nd International Workshop on Safety and Security in Multiagent Systems (SASEMAS-05), 2005.
- Bradley J. Clement, "Multiagent Planning Space Problems & Preliminary Solutions," Teamcore Group, U. Southern California, 2005.
- Bradley J. Clement, “Multiagent Planning,” PRIMA Agent School, 2004.
- Joerg Mueller, Bradley J. Clement, Suzanne K. Barber, Thomas A. Wagner, Invited Panel, “Comparing Problem Spaces,” AAMAS 2002 Comparing problem spaces. Panelists: Workshop on Multiagent System Problem Spaces

Funding

- Principal Investigator of “Distributed Scheduling for DSN and Relay/RAP Infusion” for the JPL Interplanetary Network Information Systems Directorate (FY06-FY08, $1,334K)
- Principal Investigator of “Optimal Planning Under Uncertainty” for the DARPA COORDINATORs Program (FY06-FY08, $440K)
- Principal Investigator of “Robust Planning and Scheduling Under Uncertainty” for the NASA Intelligent Systems Program (FY05-07, $1,248K, 8% of proposals awarded)
- Co-Investigator of “Dynamic Configuration and Commanding of Antenna Arrays” with Mark Johnston for the JPL Interplanetary Network Information Systems Directorate (FY06, $175K)
- Principal Investigator of “DSN Rescheduling and Optimization” for the JPL Interplanetary Network Directorate (FY05, $200K)
- Principal Investigator of “DSN Visualization & Intelligent Assistants” for the JPL Interplanetary Network Directorate (FY05, $100K)
- Principal Investigator of “Auction-Based Multi-Robot Control” for the JPL-USC Partnership Research and Development Fund (FY05, $25K)
- Principal Investigator of “Distributed Network Scheduling“ for the JPL Interplanetary Network Directorate (FY03-05, $180K)
- Principal Investigator of “DSN Requirement and Constraint Language” for the JPL Interplanetary Network Directorate (FY04, $275K)
- Principal Investigator of “Algorithms for Managing Risk and Uncertainty in Operations Planning” for the Draper Laboratory IR&D Program (FY04, $85K)
- Co-Investigator of “Adaptive Distributed Rescheduling” with David Wolpert, NASA ARC, for the NASA Intelligent Systems Mission Infusion Program (FY04, JPL portion - $100K)
- Principal Investigator of “Distributed Continual Plan Coordination“ for the JPL Interplanetary Network Information Systems Directorate (FY02)

Teaching Experience

- Tutorials:
  - Stephen F. Smith, Bradley J. Clement, Keith S. Decker, "Coordinating Distributed Planning and Scheduling Agents," July, AAAI 2007.
  - Bradley J. Clement. “Multiagent Planning and Scheduling,” ICAPS 2006.
  - Bradley J. Clement, Keith S. Decker, “Multiagent Planning: a Survey of Research and Applications.”
    - IJCAI 2005
    - AAAI 2005
    - AAMAS 2005

- Helped mentor and co-published with the following current and former graduate students:
  - Steven R. Schaffer (JPL/U. Southern California)
  - Daniel Q. Tran (JPL/U. Southern California)
  - Jeffrey Cox (U. Michigan, now at Google)
  - Thomas Bartold (U. Michigan, now at Soar Technologies)
  - Hyuckchul Jung (U. Southern California, now at Institute for Human and Machine Cognition)
- Helped with motivations and applications of projects for graduate students: Xiaoming Zheng of USC, Doran Chakraborty and Sabyasachi Saha of U. Tulsa.
- Graduate Student Instructor for Discrete Mathematics (U. Michigan)
- Guest lecture, *Advanced Topics in AI* class, University of Southern California, "AI and Space Exploration." February, 2002.
- Presented (for Steve Chien in his absence) at 4th Americas School on Agents and Multiagent Systems (2005), "Agents for Space Exploration"

Professional Activities, Service, Memberships

Co-editor, *Coordinating Agents' Plans and Schedules*, to appear as a special issue of *Multiagent and Grid Systems* (International Journal), 2008
Co-organizer of AAMAS 2007 Workshop on Coordinating Agents' Plans and Schedules
Chair of ICAPS 2005 Workshop on Multiagent Planning and Scheduling
Organizer, AAMAS Industry Track Panel, 2006
Program Committee member

- AAAI 2006, 2007, 2008 Nectar track
- AAMAS 2003, 2005—2008
- RoboCup Symposium 2002—2005
- ICAPS 2003 Workshop on Plan Execution
- AAMAS 2002 Workshop on Multiagent System Problem Spaces

Journal article review for JAIR 2006-7, JAAMAS 2006-7
Conference paper review for
IJCAI 2003, 2005, 2007, AAAI 2005, ICRA 2005, iSAIRAS 2003
Member, Association for Computing Machinery
Member, American Association for Artificial Intelligence

Computer Programming

Languages: C++, Java, Lisp, SQL, Assembly, *etc*.

Japanese Language

1 year of language study at Georgia Tech	8/93-6/94
EAGLE Program language and culture study in Kanazawa, Japan	6/94-8/94
Private tutoring in Osaka, Japan	9/94-6/96